



COVID-19: transmission, diagnosis, policy intervention, and potential broader perspective on the rapidly evolving situation in Bangladesh

Fahmida Begum Mina¹, Mutasim Billah^{3*}, Md. Siddikur Rahman¹, Sabuj Das¹, Sumon Karmakar², Md. Faruk Hasan³, Uzzal Kumar Acharjee³

¹Department of Genetic Engineering and Biotechnology, University of Rajshahi, Rajshahi-6205, Bangladesh

²Molecular Biology and Protein Science Laboratory, University of Rajshahi, Rajshahi-6205, Bangladesh

³Professor Joarder DNA & Chromosome Research Laboratory, University of Rajshahi, Rajshahi-6205, Bangladesh

*Corresponding author

Mutasim Billah,
Professor Joarder DNA &
Chromosome Research Laboratory,
University of Rajshahi, Rajshahi-6205,
Bangladesh,
E-mail: mutasimbillahshazu@gmail.com

Academic editor

Dr. Md. Masudur Rahman
Sylhet Agricultural University
Bangladesh.

Article info

Received: 17 May 2020

Accepted: 03 July 2020

Published: 07 July 2020

Keywords

COVID-19; Bangladesh; Diagnosis;
IEDCR; Quarantine; Transmission.

ABSTRACT

Following the first outbreak of COVID-19 in China, various continents became serious and aware to combat against it, though degraded dramatically preventing it, due to its unique transmission strategy. On March 8, 2020, Bangladesh confirmed its first cases of COVID-19 with three people being infected and the first death was reported on March 18, 2020, until June 29, 2020, the total number of infected people and deaths reached to 141,801 and 1783, respectively. Bangladesh has strengthened its efforts to improve the health care system's ability, including COVID-19 diagnosis to prevent the crisis, following discovery of the first 100 reported cases of COVID-19 at the start of April. Though, the government of Bangladesh had put in place preventive measures, the country has no remarkable legislative structures for combating COVID-19 in which Bangladesh, the South Asian low-income economic country, is under very precarious conditions and is at the forefront of the threat of disease that can spread to over the 160 million people. The aim of this article is to describe the current Bangladesh situation as well as the consequences in the country due to COVID-19 and to describe how people are confronted with this pandemic.

INTRODUCTION

On December 30, 2019, a series of viral pneumonia case of coronavirus infection was reported in relation to the Huanan Seafood Wholesale Market (South China Seafood City Food Market) in Wuhan, Hubei province, China. A week later, on January 7, 2020, the virus was isolated from the infected patients by Chinese Centre for Disease Control and Prevention (CCDC), which was initially referred to as novel coronavirus 2019 (2019-nCoV) because of being the new viral strain among their belonging family but given the official name 'COVID-19' by World Health Organization (WHO) on February 12, 2020 [1]. On January 20, China reported death of three COVID-19 patients and more than 200 infections, with cases also reported outside Hubei province including in

the capital Beijing, Shanghai and Shenzhen. On January 21, 2020, WHO announced that COVID-19 could be transmitted by human-to-human transmission, urging the public to take measures to protect themselves from COVID-19. Elsewhere, a Chinese infectious disease specialist reported human-to-human transmission to state broadcaster CCTV, raising fears of a major outbreak as millions traveled for the holiday of the Lunar New Year [2]. The ongoing pandemic of COVID-19 confirmed to have spread in Italy on January 31, 2020, when two tourists of China were tested positive for the virus in Rome. On February 21, 2020, 16 cases were confirmed in Lombardy, with 60 additional cases and first death was found on 22 February [3]. Nepal, which reported its first instance of COVID-19, on January 24, 2020, in a man who was from China on January 5, 2020, was the first

country to register a confirmed case in South Asia. From June 29, 2020 on, in every country of South Asia, one or more cases of COVID-19 were reported. On March 2020, it was confirmed that the pandemic COVID-19 had spread to Bangladesh. The Institute of Epidemiology, Disease Control and Research (IEDCR) reported the first three known cases on March 8, 2020 [4]. As of June 29, 2020, the COVID-19 had affected 213 countries and territories worldwide, with more than 10 million confirmed cases leading to more than 501,562 deaths and 5.6 million recoveries [5]. In a nation such as Bangladesh, in order to assemble resources and respond to those on time, early strategic planning and groundwork for evolving and setting up problems are crucial. In this review, we highlighted the transmission of COVID-19, vulnerable people for COVID-19, diagnosis, active steps taken by government officials, and possible wider consequences of COVID-19 outbreak till June 29, 2020; hoping to provide a guide for future studies and help in the prevention and control of COVID-19 pandemic in Bangladesh (Figure 1).

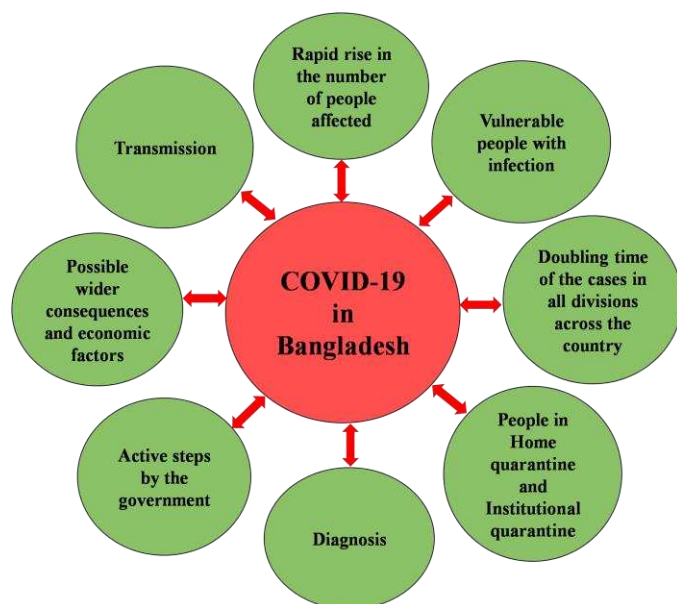


Figure 1. A schematic diagram representing the rapidly evolving COVID-19 situation in Bangladesh.

TRANSMISSION OF COVID-19

Bangladesh has confirmed its first cases of the COVID-19 as three persons were infected with the virus, including two members of one family, two of the people being infected are expatriates who have returned from Italy and the other one is a member of their family, which the Institute of Epidemiology, Disease Control and Research

(IEDCR) reported to the media on March 8, 2020 [6]. The COVID-19 detection system in Bangladesh involved instability and lack of coordination, and a solution had not been found in almost last four months of the COVID-19 outbreak that had spread from Wuhan in China [7]. While the government of Bangladesh has taken measures to identify people infected with coronavirus, various departments, including those at various airports, are in complete clutter setting. Just three thermal scanners were mounted in Dhaka and one at Sylhet and Chattogram airports each to screen a large number of inbound passengers. It was reported that the UNICEF official's arrival at the airport, her temperature was tested by a hand thermometer and no different queue maintained for female passengers [8]. A further three COVID-19 patients were identified in Bangladesh on March 16, 2020, including two females. Five more cases of COVID-19 had been identified as of March 19 and all were members of one Italy returnee's kin. There were three more cases reported on 20 March, one female and two males, among whom one was a Bangladeshi, who came back from Italy and another patient was kept in the Intensive Care Unit (ICU). At a press briefing, the health minister of Bangladesh told that China had offered assistance by providing masks, test kits and other required materials to encounter the ongoing pandemic of COVID-19. Seven new cases were reported on March 22, 2020, among which four are abroad returnees and one of them was contaminated by the other infected person coming into contact [9]. Until the end of March, infections remained low but steeply increased in April. In both the number of cases detected and the number of deaths, the country had the highest number of positive tests to date on April 6, 2020, with 35 new detected cases and 3 new deaths, raising the number from 88 to 123 and from 9 to 12, respectively. New cases in Bangladesh grew by 1,155% in the week ending on April 11, 2020, with 186% being the highest in Asia, ahead of India, Indonesia, Thailand and Sri Lanka [6]. The total number of people infected in Bangladesh reached 10,143 and the total number of deaths was increased to 182, with five deaths across the nation on April 11, 2020 [10]. COVID-19 cases reached 10,000 marks in Bangladesh on May 4, 2020, and a record 688 infected individuals were found in one day. Bangladesh hit a record of 1,202 new affected cases, crossing 20,000 marks on May 15, 2020, while the total number of cases of coronavirus in Bangladesh was reported 20065, with a total of 298 deaths. Bangladesh

crossed 40000 marks on May 28, 2020, with 2,029 new cases being reported on a single day, and till then in Bangladesh, there were a total of 40,321 COVID-19 cases, with a total of 559 deaths. Bangladesh crossed 60000 marks on June 05, 2020, recording 2,828 new cases of COVID-19 in one single day, leading the total number of cases in 60,391 with 30 more deaths, increasing the death toll to 811, having 643 recovered patients and a total of 12,804 recoveries in Bangladesh. Bangladesh reached a reported 80,000 marks on June 12, 2020 with 3,471 new cases of COVID-19 in one day and an overall figure of 81,523 cases of Bangladesh with 46 more cases of dead, and a total death count of 1,095 with 502 new recoveries, having the total number of 17,249 recoveries. On June 13, 2020, in Bangladesh, the number of cases was higher than the number of cases in China, the country where the outbreak began.

With a record of 3,803 new cases affected, Bangladesh crossed 100,000 marks in a single day on June 18, 2020. As of June 29, 2020, a record of 4,014 new cases had been registered, leading the total number of COVID-19 cases to 141,801. With 45 more death cases, the total death toll stood up to 1,783, with a total of 57,780 recoveries around the nation [6] (Figure 2).

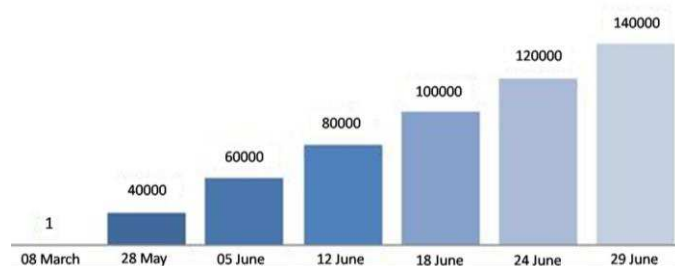


Figure 2. The rapid rise in the number of confirmed cases; from March 08, 2020 to June 29, 2020; Bangladesh. Data Source: DGHS [10].

VULNERABLE PEOPLE FOR COVID-19

Bangladesh reported the first death of the COVID-19 on March 18, 2020, the victim being a man in his early seventies, amid growing public concern about the government's preparations to control the spread of the virus [11]. The death came 11 days after the first case of coronavirus had been confirmed by the country. It was reported by IEDCR that the man had underlying health problems and was contaminated with one of his relatives

who had returned from Italy. The first person who died from the COVID-19 in Bangladesh was at the ICU in a private hospital in Dhaka and had several pre-existing health complications, such as Chronic Obstructive Pulmonary Disease (COPD), hypertension, heart disease, had a stent implanted in his heart and also diabetes [8]. On March 21, 2020, Bangladesh announced the second death, a 70-year-old man, from COVID-19 in the country. It was reported that few members of the victim's family had returned from Italy and Japan and was diagnosed with comorbidity, had been receiving treatment at a hospital in Mirpur until he died from COVID-19 [10]. An older woman in her early sixties with signs of COVID-19 died in Bangladesh as the 3rd death of COVID-19 on March 23, 2020. On April 20, 2020, Bangladesh reported ten more deaths due to COVID-19, bringing a three-digit mark on its death toll, with a number of 101, a total of COVID-19 deaths in the country, warned by the experts that in view of the growing number of death cases a visible scenario could be the tip of an iceberg [10]. On May 25, 2020, Bangladesh reached a distant landmark of 501 deaths from COVID-19. A total of 53 deaths in one day from COVID-19 was witnessed in Bangladesh on June 16, 2020, were the greatest number of deaths a day recorded. Deaths due to COVID-19 reached the country's bleak 1000 threshold on June 10, 2020. The death toll reached 1,502 on June 22, 2020 with 38 more deaths registered on that day, and as of June 29, 2020, the death toll increased to 1,787 individuals due to COVID-19 in Bangladesh [5, 6]. The elderly people and individuals with pre-existing medical conditions tend to be more vulnerable to the virus and become seriously ill [9].

As of June 29, 2020, the highest death rate of 30.1% is registered of the people who died of the disease to date were among the age group of 61-70 years. Followed by 24.9% death rate among the 51-60 age group, 16% among the 71-80 age group, 11.6% among the 41-50 age group, 7.5% among the 31-40 age group, 5.1% death rate recorded among the age group of people who were above 80 years, 3% among the 21-30 age group, 1.1% and 0.5% among the age group of 11-20 and 0-10 respectively [12]. With age, immune systems are weakening, leaving the older individuals at a significantly higher risk of developing serious complications from a respiratory disease, stated by the officials of public health. Of the total number of people infected with COVID-19 till June

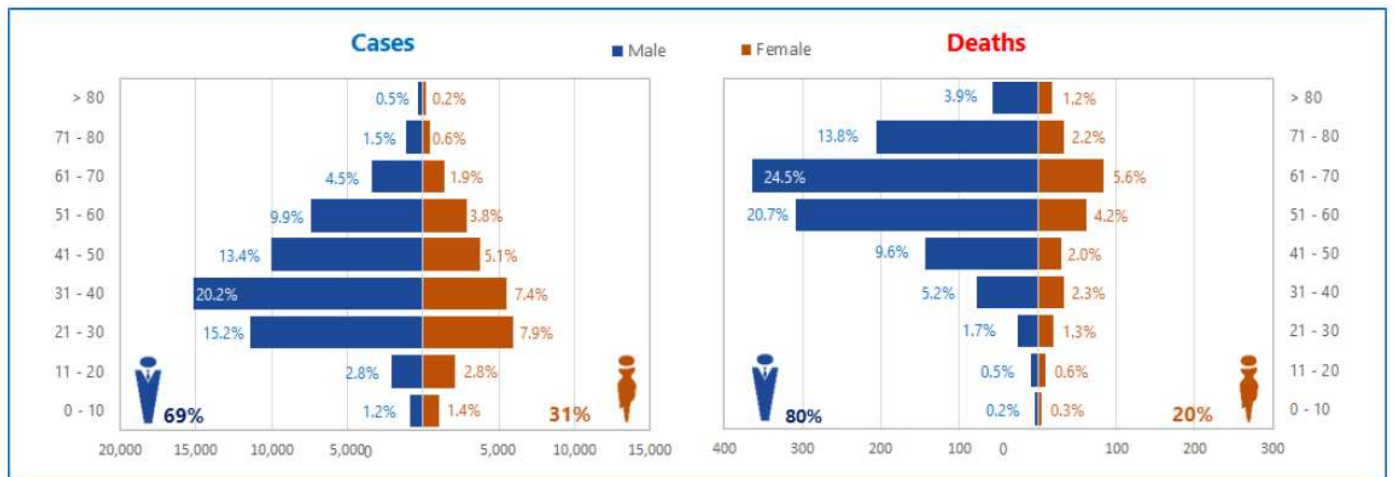


Figure 3. Infection and death rates in various age groups and gender; June 29, 2020; Bangladesh. **Source:** WHO-Bangladesh situation report-19 [12]; Permission ID: 350039.

29, 2020, the infection rate is high among the people of 31-40 and 21-30 age groups at 27.6% and 23.1% respectively, while the 3rd highest rate of infection is 18.5% among 41-50 age groups of people. The 4th highest infection rate is registered as 13.7% among the 51-60 age group of people, while the infection rate remained 6.4% as the 5th highest in 61-70 age group, followed by 5.6% among 11-20 age group. The infection rate is 2.6%, 2.1% and 0.7% among the 0-10, 71-80 and above 80 age groups respectively [12]. As of June 29, 2020, among the total number of confirmed cases, 69% infected individuals were registered as men and the rest 31% as women, while

80% death cases reported were men and 20% were women [12] (Figure 3).

It was stated by Dr. Li Zhang of the Chinese Centre for Disease Control and Prevention (CCDC) that men may have been more likely to be exposed to the virus at the start of the epidemic, for social or cultural reasons where women's reduced vulnerability to viral infections could be due to the defense of X chromosomes and sex hormones which play a major role in immunity [13].

By June 29, 2020, 100% (141,801/141,801) of the cases were subject to confirmed COVID-19 regional spread; of which 70.6% (21,079) of the confirmed cases were

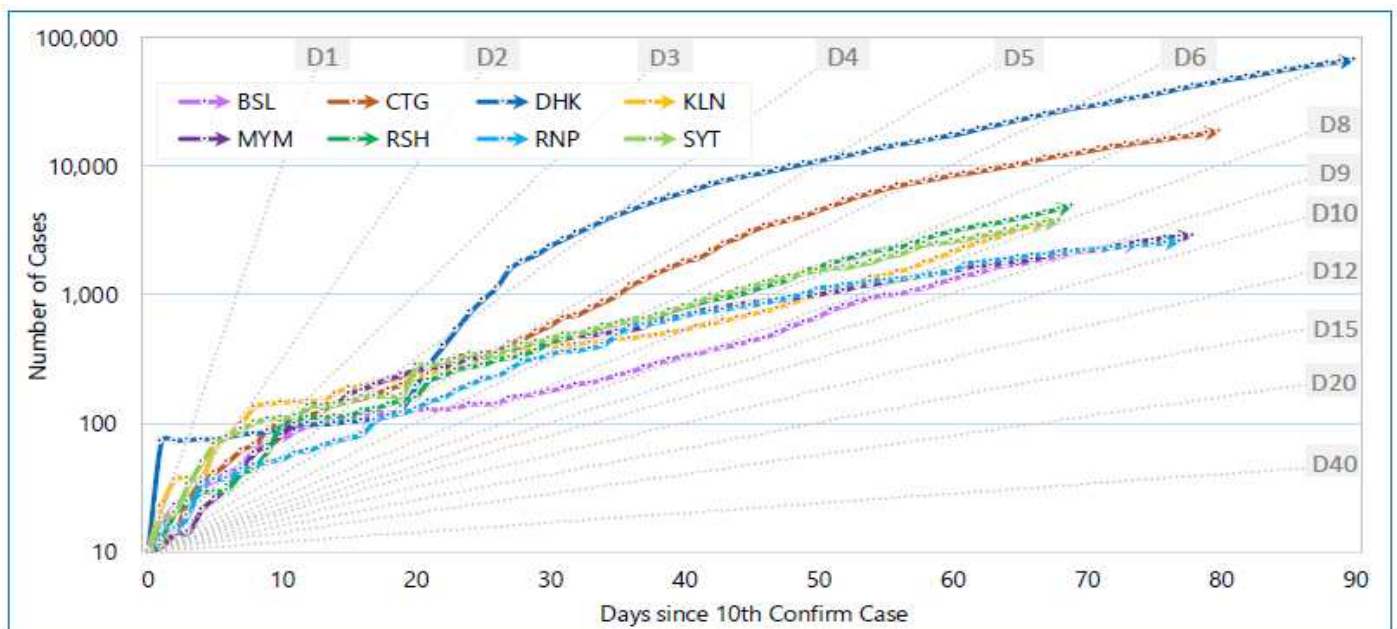


Figure 4. The case-doubling period of COVID-19 confirmed cases in all divisions around the country; from the day on which 10 cases were reported, June 29, 2020, Bangladesh. **Source:** WHO-Bangladesh situation report-19 [12]; Permission ID: 350039.

registered from Dhaka division, followed by 14.1% (4,731) from Chattogram division, 3.7% (656) from Rajshahi division, 2.9% (505) from Khulna division, 2.8% (663) from Sylhet division, 2.2% (992) from Mymensingh division, 1.9% (857) from Rangpur division, and 1.8% (231) from Barisal division, demonstrating 'Dhaka' as the most vulnerable division for COVID-19 [6, 12].

The doubling time of the confirmed cases can be used for concluding the rapid spread in Bangladesh of the COVID-19 pandemic. Parameters are represented to us to see that in various divisions in Bangladesh, the number of reported cases increased quickly. As of June 29, 2020, the time in which the cases are doubling in Dhaka division is 7 days, and in Chattogram division is 7.5 days, while in Khulna, Sylhet, Rajshahi division is 8 days, and the case doubling time is 9.5 days in Mymensingh, Rangpur and Barisal division [12] (Figure 4).

DIAGNOSIS IN BANGLADESH

COVID-19 is being diagnosed by next generation sequencing, real-time RT-PCR, cell culture, and electron microscopy in human clinical specimens all over the world [13]. There are currently several NAAT (Nucleic Acid Amplification Test) multiplex tests available commercially to identify pathogenic species in respiratory specimens in clinical virology laboratories [14-16]. The preferred method for the diagnosis of COVID-19 is the real-time reverse transcription-polymerase chain reaction (RT-PCR), which uses a nasopharyngeal swab or sputum sample sequencing [14].

Experts criticized the lack of tests carried out in this country with more than 160 million inhabitants. Newspaper and social media continued reporting further deaths of COVID-19 symptoms than the deaths reported due to COVID-19 [7]. Certain deaths were treated in COVID-19 isolation centers, while some were denied treatment in the districts, but no tests were carried out to confirm infection. Earlier, only the Institute of Epidemiology, Disease Control and Research (IEDCR) had operated COVID-19 testing in Bangladesh [10]. It was stated by Dr. ASM Alamgir, principal scientific officer of IEDCR that nasal and throat swab samples were taken from the patient at first, sample collectors were then sent from Dhaka who are experienced in collecting respiratory samples, and then the samples were processed via real-time RT-PCR, a laboratory technique for in vitro qualitative detection of COVID-19, which were only available at the IEDCR in Bangladesh [6]. The US Centers for Disease Control and Prevention suggests

using a laboratory of BSL 3 (Biosafety Level) when dealing with live viruses. In Bangladesh, two BSL3 laboratories are labeled, one at ICDDR,B and the other at IEDCR [7]. COVID-19 testing was centralized for a long time only in the IEDCR, in the capital Dhaka, although symptom patients were reported all over the country [7]. The Directorate General of Health Services (DGHS), previously, had not allowed private laboratories to conduct COVID-19 tests because they might be more interested in doing business than assisting in the crisis [10]. At first, COVID-19 research facilities were in Dhaka alone, and there was no intention to extend them outside of capital due to lack of qualified staff. The former regional adviser of WHO, Muzaherul Huq, by the end of March, advised to equip the large hospitals and institutions in the country, such as - Bangabandhu Sheikh Mujib Medical University Hospital, Combined Military Hospital, ICDDR,B, Dhaka Medical College Hospital, Chattogram Medical College Hospital, Khulna Medical College Hospital, Rajshahi Medical College Hospital, Barishal Medical College Hospital, Bogura Medical College Hospital and Rangpur Medical College Hospital to test COVID-19 in Bangladesh [5, 10].

In Bangladesh, the number of COVID-19 testing laboratories have only risen over time and approximately, 4,410 tests per million people have been carried out till June 29, 2020, that are still not enough. By June 29, 2020, a total of 751,034 COVID-19 tests were conducted by 67 laboratories, with a total positive rate of 22.5% in Bangladesh (36 laboratories in Dhaka and 32 laboratories in other divisions of the country) Laboratories inside Dhaka city tested 63.1% of all the samples of COVID-19, whereas, 37.9% of the samples were tested from laboratories outside Dhaka [12] (Figure 5).

Gonoshasthaya Kendra, a Bangladeshi private hospital, had reported to develop Rapid Dot Blot, by a technical team of Gonoshasthaya-RNA Biotech Limited, a low-priced testing kit that could analyze samples to detect Covid-19 as quickly as in 15 minutes on March 18, 2020, at a cost of Tk 2 crore. The kit developed by Gonoshasthaya-RNA Biotech Limited in Bangladesh was similar to one developed by scientists in China in January 2020, as the COVID-19 outbreak escalated in Hubei province in China. The kit uses the Rapid Dot Blot technique to identify positive cases of COVID-19 within 15 minutes and searches for antibodies that are produced in the body, in response to infection with the virus and would approximately cost less than \$3 dollar. As the rapid test is based on the presence of appropriate antibodies in the blood, factors such as duration of the test, existing infections, a person's immune system, cross-reaction with certain antigens may lead to false results. RT-PCR, under normal circumstances, is the only 'gold standard' test for COVID-19 detection but the current situation is far from

normal, and so, countries like Bangladesh suffer from intense COVID-19 test kit crisis, a rapid dot blot test could be given a fair chance [10].

In Bangladesh, On May 27, 2020, The Designated Reference Institute for Chemical Measurements (DRICM) developed viral transport media or VTM kits and reported that the chemical materials used in VTM kits are easy to collect, transport and preserve. They had supplied 5,000 kits to the Directorate General of Health Services or DGHS. The collection includes pipeline, nasal and nasopharyngeal swabs and oropharyngeal swabs. They also possess a tongue holder for easy oropharyngeal swab collections and can store samples for three days at a temperature of 4 degrees Celsius. The kits are hoped to reduce the risk of infection and contamination of samples among health workers. Such kits could also save the money used for importing swabs and tubes from Bangladesh [10].

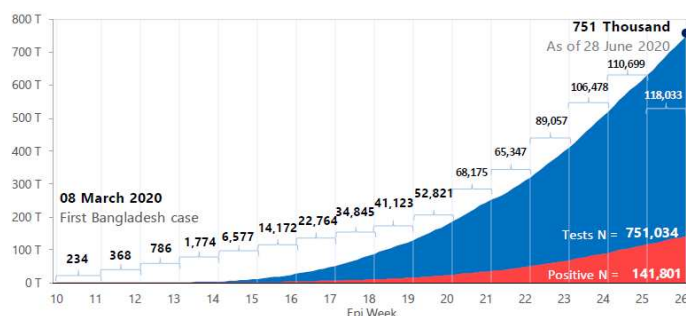


Figure 5. The cumulative number of weekly COVID-19 conducted tests and positive rates; from March 08, 2020 to June 29, Bangladesh. Source: WHO-Bangladesh situation report-19 [12]; Permission ID: 350039

ACTIVE STEPS BY GOVERNMENT

After three confirmed COVID-19 cases diagnosed in Bangladesh, the government had put in place preventive measures to combat the spread of the deadly COVID-19 strain that has shaken the world. On March 9, 2020, Prime Minister Sheikh Hasina urged the people of Bangladesh to avoid mass gathering to protect themselves from COVID-19 and instructed them not to panic [11]. Following the first discovery of cases of COVID-19 in Bangladesh, the year-long programs taken to mark the centenary of the birth of Father of the Nation Bangabandhu Sheikh Mujibur Rahman during the 'Mujib Borsho' had been rearranged in public health considerations [8, 11]. The March 17 grand rally - Mujib Borsho's flagship event - at National Parade Ground was postponed hours after the country had announced the first cases of COVID-19 on March 8, 2020, and the inauguration program had taken place in a scaled-down manner [7-8]. On the occasion of the centenary of birth of

Bangabandhu Sheikh Mujibur Rahman, the T20I series between World XI and Asia XI was postponed as a precautionary measure to avoid spread of COVID-19. The Bangladesh Ministry of Education had declared to shut down all educational institutions until 31 March, and the Dhaka University from March 18 to March 28, on March 16, 2020 to avoid spreading of COVID-19 [8]. Following India's decision to suspend all visas, with the exception of a selected few groups, the current cross-border passenger train and bus services in Indo-Bangla remained suspended from March 15 to April 15, 2020 [8]. Bangladesh suspended flights to all European countries except the UK on March 14, upon returning from Italy and Germany, two more people tested positive for COVID-19 [8, 17]. The government of Bangladesh locked down vulnerable Shibchar upazila in Madaripur district on March 19, 2020, as three more COVID-19 patients were found there. On March 21, 2020, authorities locked down Mirpur Darussalam's Tolarbagh neighborhood in the capital, hours after COVID-19 second death was reported from the city, with four new cases of COVID-19 found on March 21, 2020 [8]. The government of Bangladesh had commanded to close all bars, hotels, restaurants and clubs until March 31, 2020, expecting to curb the COVID-19 outbreak [11]. Government agreed on March 21, 2020, for the cancellation of all major events on March 26, 2020, to commemorate the Independence Day of Bangladesh. To avoid COVID-19 from spreading, the government declared a 10-point guideline, including a general holiday for both public and private offices from March 26 to April 04, 2020, and the armed forces were deployed to all districts from March 24, 2020, to support the civil administration until further instruction on March 23, 2020 [8, 11, 17]. For students from class six to ten, the Government has taken a special step to offer video lessons. This initiative, 'My School at My Home,' enables students to take subject-specific video lessons in Sangsad TV at home [10, 18].

A joint effort by five organizations to manufacture four lakh equipment was made earlier for medical doctors and nurses about the lack of personal protective equipment (PPE) in Bangladesh. The government had supplied over 2.5 million personal protective equipment (PPE) to protect caregivers and doctors. However, by the end of June 29, 2020, there are 1,235,772 PPE in stock. The government also gave doctors and nurses special training in fighting this pandemic. The teaching has now been provided by over 3.7 thousand physicians, 1.5 thousand nurses and healthcare technicians from over 500 schools. Furthermore, 10,812 physicians have completed COVID-19 online courses till the start of June 2020 [5, 6, 10].

The DGHS reports that, from June 29, 2020 onwards, 629 centers across 64 districts, with 31,991 individuals capable of receiving the existing institutional quarantine

capacity in the nation. A total of 18,864 people placed in quarantine facilities, 14,302 (75.8%) of whom were released. As of June 29, 2020, in total 25,838 individuals had been isolated in specified health facilities in the country, with a release of 10,896 (36%), and total of 12,464 (57.8%) still remaining in isolation facilities [10, 12]. On April 24, 2020, the highest number (6,547) of persons were reported on quarantine facilities and the figure has currently been reduced to 4,562. In total, 342,460 people were placed under home quarantine in every region from March 17 to June 29, 2020, with a release of 82.4% (282,063/342,460) to date. There are presently 21.4% (60,397 individuals) in home quarantine [12]; (Figure 6).

CONSEQUENCES OF COVID-19 OUTBREAK

With the COVID-19 pandemic unfolding in Bangladesh, there is increasing concern among people as public health experts had said the government lacked clarity in portraying the actual scenario. The former vice-chancellor of Bangabandhu Sheikh Mujib Medical University, Professor Md. Nazrul Islam, stated that the government had resorted to a 'bureaucratic trickery' to hide the realistic situation of COVID-19 in Bangladesh. Transparency and adequate preparedness help to keep citizens and the various authorities aware and make informed choices, but the urge to hide information or behave like the proverbial ostrich could only make things worse in this COVID-19 pandemic [10].

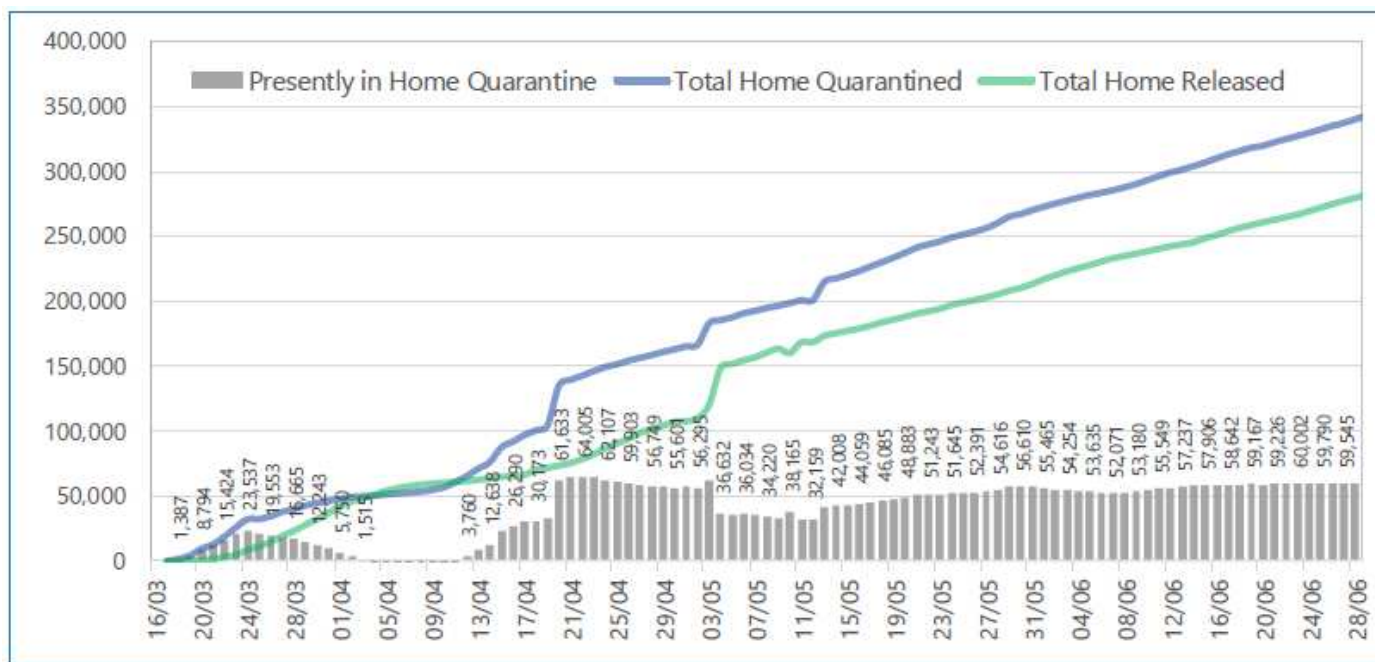


Figure 6: The number of people in home quarantine and released from quarantine; March 16, 2020 to June 29, 2020, Bangladesh. Source: WHO-Bangladesh situation report-19 [12]; Permission ID: 350039.

Apparently, COVID-19 had spread to the community transmission level in Bangladesh, reported by IEDCR. The authorities kept sticking to their argument that there was no community transmission in the region, but experts said that, too few studies had been done to reach that conclusion and recommended that the Government had to carry out more studies in all regions of the country to determine the transmission standard, and when the number of COVID-19 tests were increased, the verdict came true. The supplementary table below shows the key steps that the government has taken from January through June to counter against COVID-19 evolving situation in Bangladesh (Table 1).

Relevant age group data on percentage of cases needing hospitalization, critical care, and infection fatality ratio, we can estimate these rates in Bangladesh based on population age structure [19]. It is estimated that if one percent of the total population is infected with COVID-19, nearly 1.7 million people will be infected in Bangladesh, including physicians and healthcare staffs and scientists warned that, it has the potential to double within seven days as this strain of COVID-19 would inevitably fail and overpower the potential of the existing healthcare system in Bangladesh [20-21]. COVID-19 has brought a dramatic downturn in the world's overall lifestyle and economy in which Bangladesh has also become a victim as the rapid spread of the virus and its lethal impact made it clear that it has the capability to destroy the economy [21-22]. Asian Development Bank (ADB) estimates that Bangladesh might lose up to \$3,021

billion if the current global COVID-19 epidemic turns to the worst and expects the loss would be \$8.0 million in the best case and \$16 million, or 0.01 per cent of GDP if it ends moderately. In the sectoral scenarios in particular, the largest GDP losses and job cuts in the business sector, including the banking, industrial and public services industries, would be \$1.14 billion and 2,00,106 people respectively, followed by agriculture (\$637 million, 4.58 million people), tourism (\$510 million, 50,000 people), construction and utilities (\$400 million, 1.18 million people) and transport service (\$334 million, 67,000 people) in Bangladesh [21-23].

With the economy of Bangladesh so much dependent on China, it is apprehended that the COVID-19 outbreak may have serious consequences for Bangladesh. UNCTAD has estimated that if Bangladesh's intermediate input imports from China decrease by 2 percent due to COVID-19, it will cost Bangladesh \$16 million and probably more [19]. Leather industry will lose \$15

million. The textile and apparel sector will experience \$1 million loss in Bangladesh. The ADB has predicted that in the worst-case scenario, Bangladesh will lose around 1.1% of its GDP when the outbreak lasts for at least six months. It implies that COVID-19 will take \$3.02 billion off the economy of Bangladesh. Furthermore, it is also apprehended that a global economic downturn could lead to 4 million (approximately) job losses [23]. COVID-19 pandemic is taking a heavy toll on Bangladesh, which is the second of clothing worldwide as the textile industry is increasingly losing orders and millions of jobs are at stake [22]. On a different note, driven by the COVID-19, the global shutdown has shuttered factories and limited travel, slashing lethal emissions from greenhouse gases that heat the atmosphere. It was stated by François Gemenne, Director of the Hugo Observatory, which studies the correlations between changes in the climate, human migration and politics, that the lockdown will save more lives from pollution mitigation than the threatened COVID-19 itself [24].

Table 1. The key steps that the government has taken from January through June to counter against COVID-19 evolving situation in Bangladesh

Timeline	Active steps taken by the government of Bangladesh helping to fix the rapidly evolving COVID-19 situation in Bangladesh
January 22, 2020	Hazrat Shahjalal International Airport authorities in Dhaka, Bangladesh started screening all travelers coming from China through the thermal scanners. [7, 8, 11, 17].
January 31, 2020	Evacuated stranded Bangladeshi people from China's Wuhan city by Biman Bangladesh Airlines special flight, and all of them were in quarantine for two weeks. [7-8]
February 01, 2020	A special Bangladeshi flight evacuated 312 stranded Bangladeshi citizens in Wuhan. The evacuees were quarantined at Ashkona Hajj Camp in Dhaka and other locations for 14 days. None of them were tested COVID-19 positive. [8]
February 02, 2020	The Bangladeshi government cancelled visas on arrival of Chinese visitors here. The port of Chittagong took precautionary action to stop the spread of COVID-19 from ships carrying goods from all over the world. [7, 8, 17]
March 08, 2020	The planned elevated opening ceremony of the father of the nation of Bangladesh Bangabandhu Sheikh Mujibur Rahman's birth centenary celebration events were cancelled to avoid public gatherings which was scheduled to be held on March 17. [8, 17]
March 14, 2020	On arrival visas for all countries were suspended, and flights from all European countries other than the United Kingdom were stopped. [8, 17]
March 15, 2020	142 Passengers who had also been taken to the Ashkona Hajj camp returned from Italy. After complaining about the unsanitary conditions there, many of them had been allowed to go home with self-isolation advice. Health experts voiced grave concerns about the operation. [8, 11]
March 16, 2020	Bangladesh's Ministry of Education closed all educational institutions until 31 March 2020, which continues. [7, 8, 11, 17]
March 18, 2020	The national preparedness and response plan (NPRP) for COVID-19 was declared by the Government. [8]
March 19, 2020	The government declared its first lockdown at Madaripur's Shibchar Upazila. The government had also instructed the local authorities to suspend all political and religious conferences, cultural and social gatherings. [7, 8, 11, 17]
March 20, 2020	The Daulatdia Brothel, one of the world's largest brothels, had been ordered to close. [7]
March 21, 2020	The government had announced the cancelation of all state public programmes, including 50th Independence Day celebration and ordered not to gather to prevent the spread of COVID-19. [7, 11, 17]
March 22, 2020	i) Bangladesh's Prime Minister attended a South Asian Association for Regional Cooperation (SAARC) video conference and played an important role in creating a 'SAARC COVID-19 emergency fund' and pledged to contribute USD 1.5 million among SAARC regional countries to counter the COVID-19 pandemic. ii) Higher Secondary School Certificate Examination (public examination) was postponed until further notice. [8, 17]
March 23, 2020	The government ordered to close all government and private offices to prevent the spread of coronavirus from March 26 until April 4, 2020. It will remain open only the emergency services such as law enforcement and healthcare. [7-8]
March 24, 2020	i) The government declared a 10-day ban on all public transportation from March 26 to April 4, 2020, including water, rail and domestic air service.

		ii) In order to prevent the spread of the deadly COVID-19, the government deployed the armed forces including police and army to ensure that people maintain social distance and quarantine. [8, 17] iii) Bangladesh civil aviation authority revoked all domestic flights until April 4, 2020.
March 2020	27,	i) The government announced that three other organizations began testing for COVID-19, in addition to IEDCR. The institutions are Institute of Public Health (IPH), Dhaka Shishu Hospital, and Bangladesh Institute of Tropical and Infectious Disease (BITID). ii) Bangladesh's civil aviation authority banned all domestic and international flights, between March 30 and April 7, 2020. iii) Bangladesh received medical supplies including 30 000 COVID-19 test kits from the Jack Ma Foundation founded by the founder of Alibaba Group. [8, 17]
March 2020	31,	The honorable Prime Minister of Bangladesh executed a video-conference with top government officials of Bangladesh in a nationally televised program and outlined action, measures and plans undertaken by the Government against COVID-19. Also, the Prime Minister asked not to celebrate the Bangla New Year on April, 14. [8, 17]
April 2020	01,	Bangladesh's Ministry of Public Administration prolonged the closure until April 9. [7, 8]
April 2020	03,	100 families were put in self-isolation in Narayanganj after a deceased woman found COVID-19 positive the night before. [8, 10]
April 2020	05,	i) Bangladesh's Prime Minister declared a total stimulus package of about USD 8.5 billion (about 2.5 per cent of GDP) to cope with the effects of COVID-19 on the country's economy. ii) Again, the government extended the closure to April 14, 2020 with three general holidays. iii) Bangladesh's civil aviation authority had announced the extension of suspension until April 14, 2020 of all domestic and international flights. [8, 10]
April 2020	08,	i) The COVID-19 Multisectoral Action Plan for Bangladesh was shared with the Government of Bangladesh's Secretary of Economic Relations Divisions. COVID-19's Multisectoral Action Plan was a comprehensive plan for the international community to support MOHFW through the Health Emergency Response, Humanitarian Response, and post-pandemic socio-economic recovery assistance, including the UN and its partners. ii) Further to the 5 April meeting, members of the Consortium of Development Partners expressed their respective interest in the area(s) under the three pillars of the Country Preparedness and Response Plan (CPRP) related to health; some participants had expressed their interest in offering financial assistance for unique CPRP activities. At the same time, UN agencies also carried out re-programming of the funds to support the CPRP. iii) A new volunteer organization called "Doctors for COVID-19 Solution Bangladesh" was formed, bringing together more than 30 specialist doctors from various government and non-governmental institutions. The organization would work with regular monitoring and specialist suggestions and following proper referral system to help facilitate hospital admission. [10]
April 2020	09,	Bangladesh imposed a 'complete lockdown' on Cox's Bazar District, where most of the refugee camps of Rohingya are located. "No entry, no exit – until the situation improves," the government directive stated. [10]
April 2020	10,	The Ministry of Public Administration released a notification that the general holidays would be declared on April 15-16, and April 19-23, 2020 (April 17-18 and April 24-25 were weekends). It clarified that such holidays should not be treated as normal holidays and that the following rules would be strictly enforced during the holiday period: all residents would stay at home and leave only when necessary; legal action would be taken for those who leave after 6:00pm; travel between various locations would be limited; Government service holders were said to be stayed at their work stations in the division, district, upazila and union levels. [10, 12]
April 2020	11,	The Bangladesh Civil Aviation Authority further extended the suspension of all domestic and international flights until April 30, 2020. [8]
April 2020	12,	i) Bangladesh's government had declared a new stimulus package for the agricultural sector of a total amount of about USD 589 million. ii) The Ministry of Foreign Affairs informed all UN Agencies and International Organizations' Diplomatic Missions and Offices in Dhaka that, until 30 April 2020, foreigners with valid visas arriving in Bangladesh from any country affected by COVID-19 would be advised to remain in quarantine for two weeks after their arrival. iii) At the entry points, health officials would decide whether passengers arriving will be self-quarantined, or in government facilities. Those under self-quarantine would be monitored to strict compliance by law enforcement authorities. Diplomatic, official and Laissez-Passer holders posted in Bangladesh and members of their families with valid visas are exempted from the requirement to present a medical certificate (with English translation) within 72 hours of travel to the country to claim that he/she had no COVID-19 symptoms. iv) Diplomatic missions were asked to ensure self-quarantine if their diplomats/ employees from any COVID-19 affected country travel to Bangladesh. v) Foreign nationals staying in Bangladesh with valid visas would have the option of extending their existing visas by 3 (three) months. [10, 12]
April 2020	16,	i) The DGHS / MOHFW signed a declaration stating that "whole of Bangladesh, pursuant to section 11(1) of the infectious disease (Prevention, Control and Elimination) Act, 2018 (no 61 of 2018)" was declared an "infection risk area." [10, 12] ii) The declaration listed the same restrictions as in the previous notification issued by the Ministry of Public Affairs (all people staying at home and not going out, except for extremely emergent needs; no one was allowed to leave home from 6:00 pm to 6:00 am; restricted movement from one area to another).
April 2020	19,	i) The Ministry of Health and Family Welfare's Department of Health Services released a notification on setting up a national technical advisory committee advised the government on curbing the spread of COVID-19 and enhancing the quality of hospital medical services. ii) The President of the Medical and Dental Council of Bangladesh would lead the 17members committee and the IEDCR Director had been appointed as member secretary. The terms of reference of the Technical Committee involved advice to the government to monitor the COVID-19, advised to the government on the improvement of standards for hospitals;

		advised on improving the ability of physicians involved in providing health care; advised on what can be done to motivate the medical practitioners involved. [10, 12]
April 2020	20,	i) Bangladesh Bank had announced a 30 billion Tk refinancing fund for low-income professionals, farmers and small business owners affected by the shutdown for COVID-19. ii) The Office of the Prime Minister issued an order assigning district-wise responsibilities to Senior Secretaries and Secretaries to coordinate the activities of COVID-19 for the prevention and relief distribution. In consultation with district parliament leaders, Zilla Parishad president, public representatives, local dignitaries, and concerned officials, the appointed officials would oversee and control the health management and relief activities. They would monitor the situation of law and order in the district, and make adjustments necessary. The appointed officials would notify the ministries, departments and offices concerned about any issues/challenges and would frequently inform the office of the Prime Minister. [10, 12]
April 2020	24,	i) The Ministry of Religious Affairs announced that the number of people in mosques for evening prayers had been reduced to twelve (12) to maintain physical distance during Ramadan in the midst of the COVID-19 outbreak, including senior clerics and other mosque officials; individuals or institutions were not permitted to arrange or take part in any gathering during coronavirus outbreak over Iftar meals in the dusk. ii) The Public Administration Ministry had released a notification to extend the general holidays from 26 till 5 May 2020. [10, 12]
April 2020	27,	On 27 April 2020, the Bangladesh Civil Aviation Authority declared that it would extend the previously imposed suspension of scheduled international flights to and from Bangladesh and the suspension of all domestic commercial passenger flights until 7 May 2020. [10, 12]
May 2020	04,	i) The Public Administration Ministry issued a notification further extending the general holidays until May 14, followed by a weekend on May 15-16. The general public and the authorities concerned were reminded to follow the health advisories closely. ii) Educational institutions continued to be closed. iii) The general holidays would not be successful for the following groups and industries: vehicles and staff working in various emergency services, including electricity, water, gas, fire services, ports (land, river and sea), cleaning services, telephone and internet, and postal services; Those involved in the processing of agricultural products, fertilizers, pesticides, foodstuffs, industrial goods, government projects products / equipment, kitchen markets, food shops, pharmacies, hospitals and emergency services; physicians, health professionals, medical vehicles and other medical devices; mass media (electronic and print) personnel; factories related to pharmaceutical products and export-oriented manufacturing, ensuring workers' proper health and hygiene; and all goods-laden vehicles and cargo ships. Other development & distribution sectors, agriculture and services would be resumed in a staggered manner, taking into account the changing situation. [10, 12]
May 2020	09,	i) The DGHS announced that dengue prevalence had been increased in the country. Since fever might be present in both dengue and COVID-19 cases, in addition to COVID-19 testing, dengue testing would be performed in all patients presenting with fever at health care facilities. ii) The COVID-19 hotline was to include Dengue coverage in each District /Upazilla. The National Malaria Eradication Program distributed the kits for Dengue Rapid Diagnostic tests to all districts. iii) The DGHS arranged a video conference on Dengue management with 64 district civilian surgeons and most of the Upazilla Health and Family Planning Officers, instructed to provide the DGHS control room with all dengue-related information; and to prepare the Dengue corner in each district hospital and upazila hospital set up during the last year outbreak. [10, 12]
May 2020	14,	The general holidays and movement restrictions had been extended until 30 May 2020. The holidays were not successful for those involved in processing agricultural products, fertilizer, pesticide, foods, industrial goods, government project supplies/equipment, kitchen markets, food shops, pharmacies, hospitals and emergency services. During the holiday season, the inter-district and inter-Upazila movements were to be strictly regulated and social distance and other health-related advisories were to be maintained during shopping in Ramadan and Eid. [10, 12]
May 2020	16,	i) The Ministry of Foreign Affairs told all UN Agencies and International Organizations' diplomatic missions and offices in Dhaka about the extension of the earlier imposed suspension of commercial flights from and to Bangladesh until 30 May 2020. ii) Hand washing and sanitizing facilities were arranged at the shopping malls' entrance and should be closed by 4:00 pm. [10, 12]
May 2020	19,	The Ministry of Health and Family Welfare (MOHWF), Health Services Section issued an Office Order with instructions that any government and weekly holidays would remain operational in view of the COVID-19 situation, sample collection, transportation to laboratories, and PCR laboratory testing for COVID-19 during the Eid Holidays. [10, 12]
May 2020	28,	i) The Public Administration Ministry circulated a notification that from 31 May to 15 June 2020 the government decided to conditionally carry out the country's overall activities and public movement. This included as weekend even 5, 6, 12 and 13 June 2020. ii) During the time, all government / semi-government / autonomous offices must remain open to a limited extent under their own control, and officials should not leave their duty stations. All officials should adhere strictly to the 13-point directive issued by the Department of Health Services / Ministry of Health and Family Welfare, including always wearing a mask. iii) At least one of the national airlines announced that Dhaka AC and Shah Amanat International Airport (CGP), Chattogram, Osmani International Airport (ZYL0), Sylhet and Saidpur Airport (SPD), Rangpur would resume domestic flight operations effective 1 June 2020. [10, 12]
June 2020	04,	Announcement was made by the Ministry of Foreign Affairs (MoFA) stating, COVID-19 treatment in public or private hospital in Bangladesh may be applied to the diplomatic and official passport holders offering treatment of COVID-19. [10, 12]

June 2020	12,	In the context of “Bangladesh Risk Zone-Based COVID-19 Containment Implementation Strategy/Guide,” which is based on prevailing risks of spreading the COVID-19, the Ministry of Health and Family Welfare/DGHS introduced dividing areas in Red, Yellow and Green Zone. [10, 12]
June 2020	13,	The Coordination Branch of the Ministry of Religious Affairs released an emergency alert circular with orders to the worshipers in the Red zone area to make their own homes a sanctuary, rather than public prayer. [10, 12]
June 2020	14,	A notice was issued by the Ministry of Foreign Affairs (MoFA) claiming that if foreign investors and businessmen having a PCR-based COVID-19 negative medical certificate (with English translation) and related supporting documentation, he or she will be given on-arrival visas at the port of entry in Bangladesh. The medical certificate of COVID-19 negative must be issued within 72 hours of his/her travel to Bangladesh. [10, 12]
June 2020	15,	The Government released a Cabinet Order extending the duration from 16 June 2020 to 30 June 2020 of conditional cumulative activity and limitation on travel. [10, 12]
June 2020	21,	i) The Ministry of Public Administration released a notification that certain areas in ten (10) districts of the country are designated 'Red Zones' of compliance with the 2018 Infectious Diseases (Prevention, Control and Eradication) Act. ii) Furthermore, under conditional general holidays in the Red Zones, the Ministry of Public Administration has proclaimed them to cover a span of 21 days, and they are applicable to all officials / government workers, semi-government, autonomous and private offices / organizations of the Red Zone defined and residing outside the area. iii) These general holidays will exclude emergency services. [10, 12]

CONCLUSION

Due to social structure, economic capacity and resources, the response of different countries varied. That's why, due to its political structures, the UK strategy to combat the COVID-19 may not be the same as China. As the number of infections has increased exponentially in the following days, Bangladesh started to face crucial circumstances. The current healthcare infrastructure in Bangladesh was however also claimed not to be very strong under the Guidelines of the WHO, and, in the case of community spread of COVID-19, the government of Bangladesh may face difficulties in managing spread in the wake of a changing situation. Bangladesh alone, without the necessary support from society and private sectors, would be an unlikely challenge for the government to combat the menace. Indeed, government, non-government, independent, private, philanthropic individuals, industrialists, celebrities, sportsmen, volunteers and ordinary people are all supposed to work together in the fight against the fearful COVID-19. In addition, along with the state, citizens must preserve social isolation, their personal awareness, their basic hygiene, their self-quarantine condition and respect national and WHO laws.

ACKNOWLEDGEMENT

None

AUTHOR CONTRIBUTIONS

MB conceived and developed the concept of the study. The conception and design of this research were made by MB, FBM, MSR, SD, SK, MFH and UKA. FBM wrote

the draft of the manuscript. MB & SK analyzed the data. The review of the manuscript was performed by MFH, UKA, FBM, and MB. All authors read and revised the article, and MB approved the final manuscript and hence worked as a corresponding author.

CONFLICT OF INTEREST

The authors do not declare any conflict of interest.

REFERENCES

- [1] Li G, Fan Y, Lai Y, Han T, Lai Z, Zhou P, et al. Coronavirus infections and immune responses. *J Med Virol.* 2020;92(4):424-432. doi:10.1002/jmv.25685
- [2] Shereen MA, Khan S, Kazmi A, Bashir N, Siddique R. COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. *J Adv Res.* 2020;24:91-98. doi:10.1016/j.jare.2020.03.005
- [3] Di Lorenzo G, Di Trollo R. Coronavirus Disease (COVID-19) in Italy: Analysis of Risk Factors and Proposed Remedial Measures. *Front Med (Lausanne).* 2020;7:140. doi:10.3389/fmed.2020.00140
- [4] Bhutta ZA, Basnyat B, Saha S, Laxminarayan R. Covid-19 risks and response in South Asia. *BMJ.* 2020;368:m1190. doi:10.1136/bmj.m1190
- [5] WHO (2020). The Global Health Observatory data repository. https://apps.who.int/gho/data/node.main.HWFGRP_0020.
- [6] IEDCR (2020). COVID-19 Status Report Bangladesh. <https://www.iedcr.gov.bd/>
- [7] Huq S, Biswas RK. COVID-19 in Bangladesh: Data deficiency to delayed decision. *J Glob Health.* 2020;10(1):010342. doi:10.7189/jogh.10.010342
- [8] Islam MT, Talukder KA, Siddiqui NM, Islam T. Tackling the Pandemic COVID-19: The Bangladesh Perspective. 2020. doi:10.20944/preprints202004.0384.v1
- [9] Jahan Y, Rahman S, Rahman A. COVID-19: A case report from Bangladesh perspective. *Respir Med Case Rep.* 2020;30:101068. doi:10.1016/j.rmcr.2020.101068
- [10] DGHS (2020). Situation analysis of novel COVID-19. <https://corona.gov.bd/press-release>.
- [11] Siddika A, Islam DM. COVID-19 and Bangladesh: A study of the

public perception on the measures taken by the government. 2020. doi:10.13140/RG.2.2.30042.49608

- [12] WHO (2020). Coronavirus disease 2019 (COVID-2019) Bangladesh Situation Report-18. [https://www.who.int/bangladesh/emergencies/coronavirus-disease-\(covid-19\)](https://www.who.int/bangladesh/emergencies/coronavirus-disease-(covid-19))
- [13] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med.* 2020;382(8):727-733. doi:10.1056/NEJMoa2001017
- [14] Beckmann C, Hirsch HH. Comparing Luminex NxTAG-Respiratory Pathogen Panel and RespiFinder-22 for multiplex detection of respiratory pathogens. *J Med Virol.* 2016;88(8):1319-1324. doi:10.1002/jmv.24492
- [15] Huang HS, Tsai CL, Chang J, Hsu TC, Lin S, Lee CC. Multiplex PCR system for the rapid diagnosis of respiratory virus infection: systematic review and meta-analysis. *Clin Microbiol Infect.* 2018;24(10):1055-1063. doi:10.1016/j.cmi.2017.11.018
- [16] Babady NE, England MR, Smith JLK, He T, Wijetunge SD, Tang WY, et al. Multicenter evaluation of the ePlex respiratory pathogen panel for the detection of viral and bacterial respiratory tract pathogens in nasopharyngeal swabs. *J Clin Microbiol.* 2018;56(2):e01658-17. doi:10.1128/JCM.01658-17
- [17] Anwar S, Nasrullah M, Hosen MJ. COVID-19 and Bangladesh: Challenges and How to Address Them. *Front Public Health.* 2020;8:154. doi:10.3389/fpubh.2020.00154
- [18] Shammi M, Bodrud-Doza M, Towfiqul Islam ARM, Rahman MM. COVID-19 pandemic, socioeconomic crisis and human stress in resource-limited settings: A case from Bangladesh. *Heliyon.* 2020;6(5):e04063. doi:10.1016/j.heliyon.2020.e04063
- [19] Islam MS, Rahman KM, Sun Y, Qureshi OM, Abdi I, Chughtai AA, et al. Current knowledge of COVID-19 and infection prevention and control strategies in healthcare settings: A global analysis. *Infect Control Hosp Epidemiol.* 2020;1-11. doi:10.1017/ice.2020.237
- [20] Imai N, Dorigatti I, Cori A, Donnelly C, Riley, Ferguson MN. Report 2: Estimating the potential total number of novel Coronavirus cases in Wuhan City, China. (2020). doi:10.25561/77150
- [21] Amit S. Long read: coronavirus and the Bangladesh economy: navigating the global COVID-19 shutdown. *South Asia@ LSE.* 2020 <http://eprints.lse.ac.uk/104465/>
- [22] Kar SK, Arafat SMY, Sharma P, Dixit A, Marthoenis M, Kabir R. COVID-19 pandemic and addiction: Current problems and future concerns. *Asian J Psychiatr.* 2020;51:102064. doi:10.1016/j.ajp.2020.102064
- [23] Bhuiyan AKMI, Sakib N, Pakpour AH, Griffiths MD, Mamun MA. COVID-19-Related Suicides in Bangladesh Due to Lockdown and Economic Factors: Case Study Evidence from Media Reports. *Int J Ment Health Addict.* 2020;1-6. doi:10.1007/s11469-020-00307-y
- [24] Qu G, Li X, Hu L, Jiang G. An Imperative Need for Research on the Role of Environmental Factors in Transmission of Novel Coronavirus (COVID-19). *Environ Sci Technol.* 2020;54(7):3730-3732. doi:10.1021/acs.est.0c01102.



This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.